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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 15

Application Number: 09/945,065
Filing Date: August 30, 2001
Appellant(s): DERAA ET AL.

Linda H. Liu
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed October 20, 2003.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

The amendment after final rejection filed on July 24, 2003 has not been entered.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

Appellant's brief includes a statement that claims 1-4 and 6-20 do not stand or fall together and provides reasons as set forth in 37 CFR 1.192(c)(7) and (c)(8).

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

6,404,058	Taguwa	06-2002
6,262,485	Thakur et al.	07-2001
6,355,558	Dixit et al.	03-2002

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-4, 6-7, 9-14 and 16-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Taguwa (US 6,404,058) in view of Thakur et al. (US 6,262,485), hereinafter Thakur.

Regarding claim 1, Taguwa shows in Fig.3C an integrated circuit comprising:

a silicon substrate 201;

an insulating layer 204 formed on the silicon substrate wherein the insulating layer has an opening that extends from an upper surface of the insulating layer to an upper surface of the substrate as to expose the upper surface of the substrate;

a metal layer 209 formed in the opening wherein a first portion (a bottom portion) of the metal layer is formed on the exposed upper surface of the substrate wherein a second portion (a side portion) of the metal layer does not contact the substrate and remains unreacted; and

a metal silicide layer 210 on an upper surface of the second portion of the metal layer, wherein the metal silicide layer adheres the second portion of the metal layer to a metal nitride layer 211 that is subsequently formed on the first and the second portions of the metal layer.

Taguwa shows a structure of the device substantially identical to the instant invention except a metal silicide layer formed in the exposed region of the substrate through the reaction of the metal layer with silicon. Thakur shows a device with a contact hole forming a metal silicide layer (a titanium silicide layer 530 in Fig. 5C) in a silicon substrate through annealing the deposited metal layer (a titanium layer; col. 7, lines 6-43).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to employ the teachings of Thakur for the device of Taguwa in order to form a metal silicide region in a silicon substrate to decrease the ohmic resistance of a contact hole interconnection (col. 3, lines 62-64).

Note that Taguwa discloses the adhesive property of titanium silicide (metal silicide) throughout the specification, especially in col. 3, lines 9-51.

Regarding claim 2, Taguwa teaches in Fig. 3C the metal layer 209 comprises titanium.

Regarding claim 3, Taguwa teaches in Fig. 3C the metal nitride layer 211 comprises titanium nitride

Regarding claim 4, Taguwa teaches in Fig. 3C the metal silicide adhesion layer 210 comprises titanium silicide.

Regarding claim 6, Taguwa shows the metal silicide adhesion layer is approximately 50 150 angstrom thick (col. 5, line 49).

Regarding claim 7, Taguwa shows in Fig. 3C the opening is a contact opening.

Regarding claim 9, Taguwa shows in Fig. 3C the exposed upper surface of the substrate comprises a junction region 203.

Regarding claim 10, Taguwa shows in Fig. 3C an integrated circuit comprising a contact fill 212, 213 formed on an upper surface of the titanium nitride layer wherein the contact fill substantially fills the contact opening.

Regarding claim 11, Taguwa shows in Fig. 3C the contact fill 213 comprises titanium nitride.

Regarding claim 12, Taguwa discloses the titanium nitride contact fill comprises TiC14 based titanium nitride (col. 5, lines 55-57).

Regarding claim 13, Thakur discloses the contact fill comprises tungsten to form a low resistance interconnect (col. 4, lines 6-7).

Regarding claim 14, Taguwa discloses in Fig. 3C, a high aspect ratio contact structure formed over a junction region in a silicon substrate 201, comprising:

an insulating layer 204, wherein the insulating layer defines a contact opening, wherein the contact opening is formed over the junction region 203 of the substrate and exposes a portion of the substrate 201;

a titanium layer 209 formed in and adjacent the contact opening, wherein a first portion (a side portion) on the insulating layer and a second portion (a bottom portion) on the exposed

substrate layer, wherein at least a portion of the second portion of the titanium layer contacts the exposed substrate, wherein the first portion of the titanium layer does not contact the substrate;

a titanium silicide layer 210 formed on an upper surface of the first and the second portions of the titanium layer;

a titanium nitride contact fill 211 formed in and adjacent the opening, wherein the titanium nitride is formed on an upper surface of the titanium silicide layer, wherein the titanium nitride contact fill is adhered to the first portion of the titanium layer by the titanium silicide.

Taguwa shows a structure of the device substantially identical to the pending claim except a metal silicide layer formed in the exposed region of the substrate through the reaction of the metal layer with silicon. Thakur shows a device with a contact hole forming a metal silicide layer (a titanium silicide layer 530 in Fig. 5C) in a silicon substrate through annealing the deposited metal layer (a titanium layer; col. 7, lines 6-43).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to employ the teachings of Thakur for the device of Taguwa in order to form a metal silicide region in a silicon substrate to decrease the ohmic resistance of a contact hole interconnection (col. 3, lines 62-64).

Note that Taguwa discloses the adhesive property of titanium silicide throughout the specification, especially in col. 3, lines 9-51.

Regarding claim 16, Taguwa shows the titanium nitride contact fill comprises TiCl4 based titanium nitride (col. 5, lines 55-57).

Regarding claim 17, Taguwa shows the insulating layer comprises BPSG (col. 2, lines 21-23).

Regarding claim 18, Taguwa shows the metal silicide adhesion layer is approximately 50-150 angstrom thick (col. 5, line 49).

Regarding claim 19, Thakur et al. teach to implant silicon within the titanium at the bottom of the contact hole (col. 7, lines 16-17). The silicide formed on annealing will therefore be interspersed in a titanium rich layer.

Regarding claim 20, Taguwa shows inherently the titanium silicide adhesion layer inherently comprises less chlorine than the titanium rich layer (col. 5, lines 2-51).

Claims 8 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Taguwa and Thakur as applied to claims 1 and 14 above, and further in view of Dixit et al. (US 6,355,558), hereinafter Dixit.

Regarding claims 8 and 15, the combined teachings of Taguwa and Thakur show most aspect of the instant invention except "the contact opening has an aspect ratio of at least 10:1."

However, Dixit et al show a device with a contact hole having an aspect ration of 10:1 (col. 3, line 64).

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify an aspect ratio of the contact hole in the device of Taguwa and Thakur with the teachings of Dixit since a contact hole with such an aspect ratio complies the current trend of the effort to minimize the size of the memory cell and improve the reliability of interconnection metals.

(11) Response to Argument

None Of The References Cited By The Examiner Either Alone Or In Combination, Teach An Integrated Circuit Contact Structure Having A Metal Silicide Adhesion Layer. That Serves Both As An Adhesion Enhancement Layer And A Refractory Metal Silicide Layer.

Appellant mainly argues "none of the references cited by the Examiner, either alone or in combination, teach an integrated circuit contact structure having a metal silicide adhesion layer that functions both as an adhesion layer and a refractory metal layer."

First, the metal silicide adhesion layer in the instant invention is not a refractory metal layer. It is a refractory metal compound layer since it is formed of titanium silicide (TiSi).

Second, with this understanding, Fig. 3C of Taguwa explicitly shows a titanium silicide layer (210) formed between the titanium layer and the titanium nitride layer. As disclosed in column 3, line 24-51, the titanium nitride layer is less adhesive to the titanium, therefore, resulting in a thermal stress. And Taguwa further discloses that a refractory metal silicide (a titanium silicide) is used to absorb this stress. This aspect clearly shows that the titanium silicide of Taguwa serves to enhance the adhesion between the titanium and the titanium silicide.

In addition, it should be noted that all of Appellant's layers are formed of the same material of Taguwa's; therefore, Taguwa's titanium silicide layer should have the same function of enhancing the adhesion.

Finally, regarding Appellant's contention over differences in the process, the rejected claims 1-4 and 6-20 are directed to device not to a method of making a device.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

jmi
June 20, 2004

Conferees
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